American National Standard

for information systems –

unrecorded magnetic tape cartridge for information interchange – 0.250 inch (6.30 mm), 6400-10 000 ftpi (252-394 ftpmm)

ANSI X3.127-1987

american national standards institute, inc
1430 broadway, new york, new york 10018

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X3.127-1987

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for Information Systems –

Unrecorded Magnetic Tape Cartridge for Information Interchange – 0.250 inch (6.30 mm), 6400-10 000 ftpi (252-394 ftpmm)

Secretariat

Computer and Business Equipment Manufacturers Association

Approved November 5, 1986

American National Standards Institute, Inc

American National Standard

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Foreword

(This Foreword is not a part of the American National Standard X3.127-1987.)

This standard presents the minimum requirements for the physical and magnetic interchange of a 0.250-inch (6.30-mm) -wide magnetic tape cartridge between information processing systems, communication systems, and associated equipment utilizing the standard code for Information Interchange. This standard supports recording densities of 6 400 to 10 000 ftpi and complements American National Standard for Information Processing – Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded, ANSI X3.55-1982. Further improvements over ANSI X3.55-1982 are as follows:

(1) Provides for a tape length of 550 feet in addition to 450 feet

(2) Defines and gives requirements and test methods for instantaneous speed variation (ISV)

(3) Defines and gives requirements and test methods for defect density in place of dropouts.

(4) Expands the requirements for tape tension to include instantaneous tension, dynamic tension, and transverse tension

The X3B5 Subcommittee on Magnetic Tape, which developed this standard, consists of a number of experienced and qualified specialists on the recording of digital information on magnetic tape. In the development of this standard, careful consideration was given to current practices, existing equipment and supplies, and the broadest possible acceptance, and to providing a basis for future improvement in the use of the medium.

Suggestions for improvement of this standard will be welcome. They should be sent to the Computer and Business Equipment Manufacturers Association, 311 First Street, NW, Washington, DC 20001.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Information Processing Systems, X3. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

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American National Standard for Information Systems –

Unrecorded Magnetic Tape Cartridge for Information Interchange – 0.250 inch (6.30 mm), 6400-10 000 ftpi (252-394 ftpmm)

1. Scope and Introduction

1.1 Scope

1.1.1 This American National Standard for an unrecorded cartridge containing 0.250-inch (6.30-mm)-wide magnetic tape presents the minimum requirements for the mechanical and magnetic interchangeability of the cartridge between information processing systems, using physical recording densities in the range of 6400 to 10 000 flux transitions per inch (ftpi) (252 to 394 flux transitions per millimeter (ftpmm)).

1.1.2 The magnetic tape cartridge consists of two coplanar hubs loaded with 0.250-inch (6.30-mm)-wide magnetic tape (Figure 1). The tape is transported between hubs by an internal belt that is coupled by an internal belt capstan to the external drive. No tape-driving or position-sensing elements penetrate the cartridge.

1.1.3 This standard applies to cartridges used for data interchange. Where it applies to cartridge testing only, it is specifically stated.

CAUTION NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights.

By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith. The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions, to applicants desiring to obtain such a license. Details may be obtained from the publisher.

No representation or warranty is made or implied that this is the only license that may be required to avoid infringement in the use of this standard.

1.2 Introduction

1.2.1 This standard defines the requirements and supporting test methods necessary to ensure interchange at acceptable performance levels. It is distinct from a specification in that it delineates a minimum of restrictions consistent with compatibility in interchange transactions.

1.2.2 The performance levels contained in this standard represent the minimum acceptable levels of performance for interchange purposes. They therefore represent the performance levels that the interchanged items should meet or surpass during their useful life and thus define end-of-life criteria for interchange purposes. The performance levels in this standard are not intended to be employed as substitutes for purchase specifications.

1.2.3 Wherever feasible, quantitative performance levels that shall be met or exceeded in order to comply with this standard are given. In all cases, including those in which quantitative limits for some of the requirements falling within the scope of this standard are not stated but are left to agreement between interchange parties, standard test methods and measurement procedures shall be used to establish such quantities.

1.2.4 U.S. Engineering Units are the original dimensions in this standard. Conversions of toleranced dimensions from customary U.S. Engineering Units (similar to British Imperial Units) to SI units have been done in this standard in accordance with Method A as described in American National Standard Metric Practice, ANSI/IEEE 268-1982, and as described in International Standard for Toleranced Dimensions – Conversion from Inches into Millimetres and Vice Versa, ISO 370-1975. Method A should be used for economy unless a requirement for absolute assurance of a fit justifies use of Method B. In the national standards of ISO member nations, additional rounding may be done to produce "preferred" values. These values should lie within or close to the original tolerance ranges.

1.2.5 Except as indicated in 1.2.3, interchange parties complying with the applicable standards should be able to achieve compatibility without need for additional exchange of technical information.

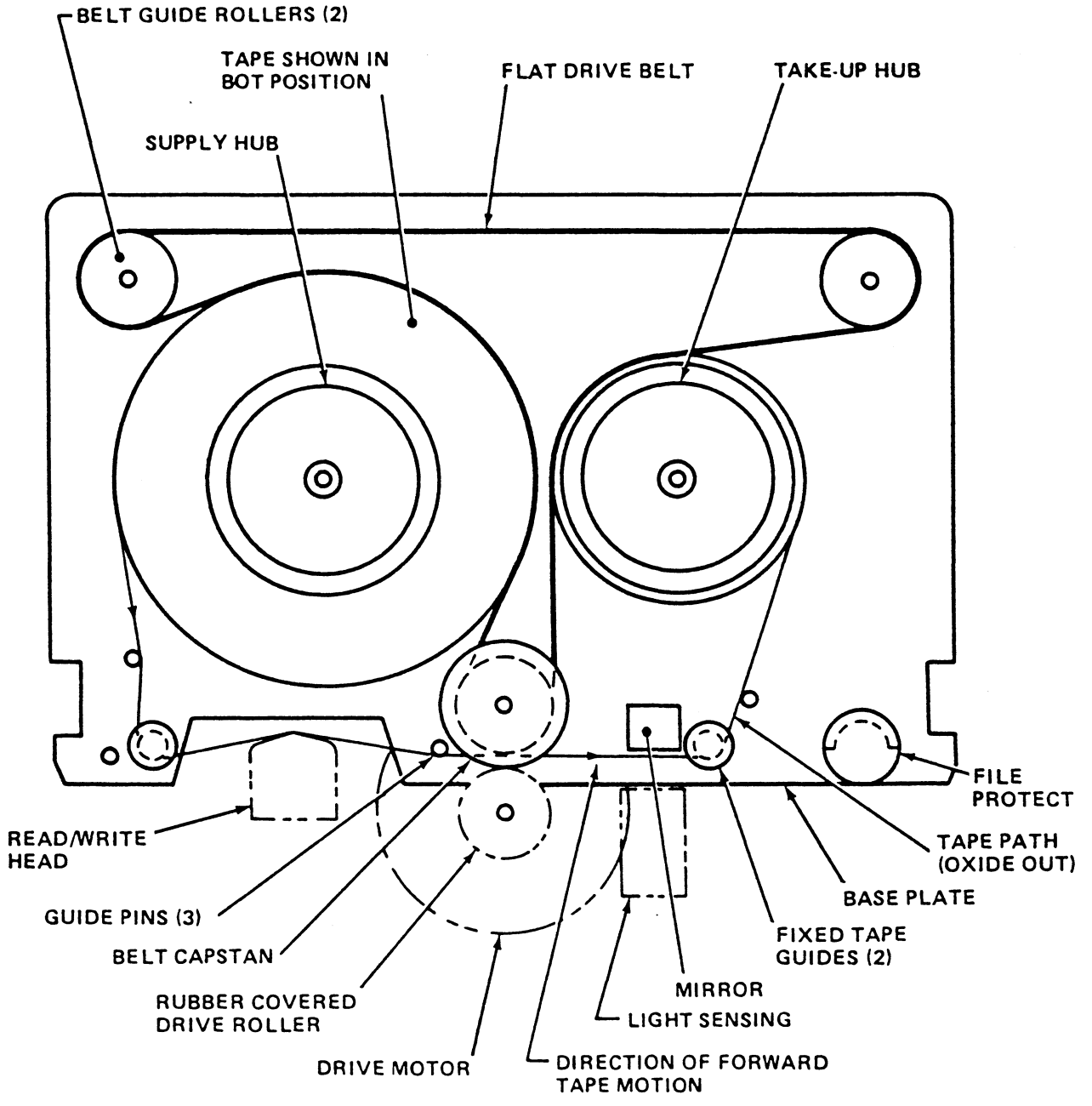


Figure 1
Possible Configuration of Cartridge

2. Referenced Standards

2.1 American National Standards. This standard is intended to be used in conjunction with the following American National Standards. When these standards are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply:

ANSI X3.55-1982, Information Processing – Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded

ANSI/IEEE 268-1982, Metric Practice

2.2 Other Standards. This standard is also intended to be used in conjunction with International Standard for Toleranced Dimensions – Conversion from Inches into Millimetres and Vice Versa, ISO 370-1975.[1]

3. Definitions

3.1 Magnetic Tape. A tape that accepts and retains magnetic signals intended for input/output and storage purposes for information processing and associated systems.

3.2 Reference Tape Cartridge. A tape cartridge selected for a given property for calibrating purposes.

3.3 Secondary Reference Tape Cartridge. A tape cartridge intended for routine calibrating purposes, the performance of which is known and stated in relation to that of the Reference Tape Cartridge.

3.4 Typical Field. The minimum field that, when applied to the tape under test, causes a signal output equal to 95% of the maximum signal output at the specified test density.

3.5 Reference Field. The minimum field that, when applied to the signal amplitude reference tape cartridge, causes a signal output equal to 95% of the maximum signal output at the specified test density.

3.6 Test Recording Currents. The two recording currents are:

(1) Between 148% and 152% of the current required to produce the reference field at 6400 ftpi (252 ftpmm)

(2) Between 128% and 132% of the current required to produce the reference field at 10 000 ftpi (394 ftpmm)

[1] Available from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

3.7 Signal Amplitude Reference Tape Cartridge. A reference tape cartridge selected as a standard for signal amplitude and reference field.[2]

3.8 Standard Reference Amplitude. The average peak-to-peak signal amplitude output of the signal amplitude reference tape cartridge when it is recorded with the appropriate test recording current on the NBS measurement system at each test physical recording density. The signal amplitude shall be averaged over 10 000 flux transitions.

3.9 Flux Transition. The position of a flux transition is defined as that point that exhibits the maximum free-space flux density normal to the tape surface.

3.10 Physical Recording Density. The number of recorded flux transitions per unit length of track, usually expressed in flux transitions per inch (ftpi) or flux transitions per millimeter (ftpmm).

3.11 In Contact. An operating condition in which the oxide side of the tape is in physical contact with a magnetic head.

3.12 Beginning of Tape (BOT) Marker. A set of two holes punched in the tape. There are three sets of holes provided, the innermost of which is used for the purpose of identifying the storage position for the cartridge. The additional sets of holes are used to ensure reliability of detection (see Figure 2).

NOTE: In the storage position, all of the usable recording area is wound on the supply hub and is protected by at least one layer of tape. Cartridges to be interchanged shall be rewound to the storage position prior to interchange.

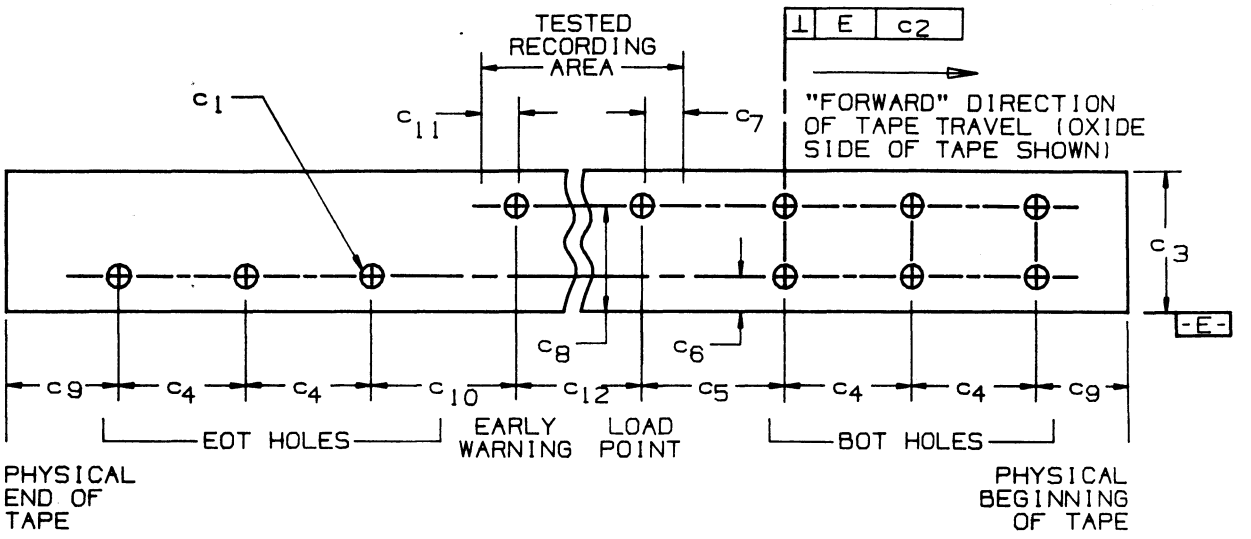
3.13 End of Tape (EOT) Marker. A single hole punched in the tape. There are three holes along a single line. The first to pass the photosensor during forward operation indicates that the usable recording area has been exceeded. The additional holes are used to ensure reliability of detection (see Figure 2).

3.14 Load Point (LP) Marker. A single hole punched in the tape to indicate the beginning of the usable recording area in the forward direction (see Figure 2).

3.15 Early Warning (EW) Marker. A single hole punched in the tape to indicate the approaching end of

[2] A Master Standard (Computer Amplitude Reference) Cartridge has been selected by the National Bureau of Standards (NBS) to establish the reference level for average peak-to-peak signal amplitudes when recorded at 6400 ftpi (252 ftpmm) and 10 000 ftpi (394 ftpmm).

Secondary Standard Amplitude Reference Tape Cartridges are available from NBS under Part Number SRM 3217. For ordering information, contact: Office of Standard Reference Materials, Room B311, Chemistry Building, National Bureau of Standards, Gaithersburg, MD 20899.



Dimension	Inches	Millimeters	Feet	Meters
c_1 (11X)	0.046 ± 0.002*	1.17 ± 0.05*	–	–
c_2 (3X)	0.005	0.13	–	–
c_3	$0.2470^{+0.0010}_{-0.0015}$	$6.274^{+0.025}_{-0.038}$	–	–
c_4 (4X)	18 ± 3	457 ± 76	–	–
c_5 (2X)	36 ± 3	914 ± 76	–	–
c_6	0.059 ± 0.004	1.50 ± 0.10	–	–
c_7	27†	686†	–	–
c_8	0.187 ± 0.004	4.75 ± 0.10	–	–
c_9 (2X)	15†	381†	–	–
c_{10}	48 ± 3	1219 ± 76	–	–
c_{11}	39†	991†	–	–
c_{12}	–	–	450 + 15, – 0‡ 550 + 15, – 0§	137.2 + 4.6, – 0‡ 167.6 + 4.6, – 0§

*Diameter
†Minimum
‡LL Cartridge
§XLL Cartridge

Figure 2
Position Holes for Tape

the usable recording area in the forward direction. Recording shall halt before the EOT marker is sensed (see Figure 2).

3.16 Track. A longitudinal area on the tape along which a series of magnetic signals may be recorded.

3.17 Tested Recording Area. The portion of the tape (as shown in Figure 2) tested in accordance with 5.2.

3.18 Average Signal Amplitude. The average peak-to-peak value of the signal output measured over a minimum distance of 1.0 inch (25.4 mm).

3.19 Long Length (LL) Cartridge. A cartridge nominally containing 450 feet (137.2 meters) of tape between LP and EW markers (see 5.1.2 and Figure 2).

3.20 Extra Long Length (XLL) Cartridge. A cartridge nominally containing 550 feet (167.6 meters) of tape between LP and EW markers (see 5.1.2 and Figure 2).

4. General Requirements

4.1 Testing Environment. Tests and measurements made on the cartridge to check the requirements of this standard shall be carried out under the following conditions:

Temperature: 68°F ± 7°F (20°C ± 4°C)

Relative humidity:	50% ± 10%
Condition before testing:	24 hours
Maximum wet bulb temperature:	64°F (18°C)

4.2 Operating Environment. Cartridges used for data interchange shall be operated under the following conditions:

Temperature:	41-113°F (5-45°C)
Relative humidity:	20-80% noncondensing
Maximum wet bulb temperature:	79°F (26°C)

The temperature shall be measured in the air immediately surrounding the cartridge. Rapid temperature variations should be avoided. There shall be no deposit of moisture on or in the cartridge.

4.3 Transportation Environment. During transportation, the cartridge may be exposed to conditions outside the operating environment. The recommended safe limits shall be:

Temperature:	-40-113°F (-40-45°C)
Relative humidity:	20-80% noncondensing
Maximum wet bulb temperature:	79°F (26°C)

If it is suspected that the cartridge has been subjected to mechanical shock simultaneously with exposure to cold, as evidenced by tape pack shift, the cartridge should be conditioned as described in 4.5.

4.4 Storage Environment. During storage, the cartridge should be in an environment not to exceed the conditions of the transportation environment. Cartridges that have been exposed to temperatures above 113°F (45°C) may still be able to function usefully with a high probability of retrieving data stored on them. Under no circumstances should cartridges be exposed to temperatures in excess of 167°F (75°C) as permanent damage may occur.

4.5 Conditioning of the Cartridge. Before use, the cartridge shall be conditioned by exposure to the operating environment for a time at least equal to the period during which it has been out of the operating environment (up to a maximum of 8 hours).

The cartridge shall also be conditioned by running the tape one complete end-to-end pass in any of the following cases:

(1) Each time that it is inserted into a drive

(2) After prolonged operation over a limited area

(3) When the temperature change to which the cartridge has been exposed is greater than 30°F (17°C).

4.6 Flammable Material. Tape or cartridge components that will ignite from a match flame, and when so ignited will continue to burn in a still carbon dioxide atmosphere, shall not be used.

4.7 Toxicity. Tape or cartridge components that may cause bodily harm by contact, inhalation, or ingestion during normal use of the cartridge shall not be used.

5. Characteristics of the Tape

5.1 Mechanical Properties

5.1.1 Tape Width and Tolerance. The tape width shall be 0.2470 inch + 0.0010 inch, -0.0015 inch (6.274 mm + 0.025 mm, -0.038 mm).

5.1.2 Tape Length. The tape length between LP and EW markers shall be 450 feet + 15 feet, -0 feet (137.2 meters + 4.6 meters, -0.0 meters) for the LL cartridge, and 550 feet + 15 feet, -0 feet (167.6 meters + 4.6 meters, -0.0 meters) for the XLL cartridge.

5.1.3 Tape Thickness. The overall thickness of the tape shall be 750 microinches (19.0 micrometers), maximum. The oxide coating thickness shall be 260 microinches (6.6 micrometers), maximum.

5.1.4 Tape Position Holes. Tape position holes for beginning of tape, load point, early warning, and end of tape shall be provided as shown in Figure 2. These position holes used as tape markers are symmetrically located to allow bidirectional tape control.

5.1.5 Leaders and Splices. The cartridge shall contain no splices or spliced-in leaders.

5.1.6 Tape Wind. The tape shall be wound on the hubs with the magnetic coating out, and in such a way that, during forward read/write operations, the tape is unwound in a counterclockwise direction viewed from the top of the cartridge as shown in Figure 1.

5.1.7 Tensile Yield Force

5.1.7.1 Definition. The tensile yield force shall be taken as the force required to elongate the sample 3 percent.

5.1.7.2 Requirement. The tensile yield force at 3 percent elongation shall be minimum of 1.5 lbf (6.7 N).

5.1.7.3 Procedure. Use a static-weighting, constant rate-of-grip separation tester capable of indicating the load to an accuracy of ±2 percent. Clamp a specimen of tape at least 7 inches (178 mm) in length, with an initial 4-inch (102-mm) separation between the jaws. Elongate the specimen at a rate of 2 in/min (51 mm/min) until the minimum elongation of 10 percent is reached. Record the load indicated when the sample reaches an elongation of 3 percent.

5.1.8 Electrical Resistance

5.1.8.1 Definition. Electrical resistance is defined as the resistance of the oxide coating surface, measured in ohms per square.

5.1.8.2 Requirement. The resistance shall not exceed 10^9 ohms per square, but shall be greater than 5×10^5 ohms per square.

5.1.8.3 Procedure. After being exposed to the test environment for 12 hours, place two layers of the sample tape back-to-back between the strip electrodes, as shown in Figures 3 and 4, such that the magnetic-oxide-coated sides are in contact with all of the electrodes. In mounting the specimen for measurement, it is important that no conducting paths exist between the electrodes, except those through the specimen. To ensure that the length of tape held between each strip electrode is the same, place the specimen under a tension of 8 ozf ± 2 ozf (2.23 N ± 0.56 N) as it is being clamped.

NOTE: Neither the specimen nor the insulating surfaces shall be handled with the bare fingers. (Clean, lint-free gloves should be used.)

5.1.8.4 Results. Measurement shall be made between each pair of adjacent electrodes. The resistance of the coating shall be determined by averaging the resistance (see Figure 4) calculated from each of the 5 measurements, using a dc potential source of 500 volts ± 10 volts.

5.1.9 Layer-to-Layer Adhesion

5.1.9.1 Definition. Layer-to-layer adhesion refers to that property of a magnetic tape wherein one layer when held in close proximity to the adjacent layer exhibits an adhesive nature and bonds itself to an adjacent layer so that free and smooth separation of the layers is difficult.

5.1.9.2 Requirement. There shall be no evidence of layer-to-layer adhesion or coating delamination.

5.1.9.3 Procedure. Using non-oozing adhesive material, fasten one end of a 3-foot (914-mm) length of tape, magnetic side down, to a stainless steel tube that is 4 inches (102 mm) long and 0.5 inch (12.7 mm) in diameter with a wall thickness of 0.030 inch ± 0.010 inch (0.076 mm ± 0.26 mm). Attach the opposite end of the tape to a 0.67-pound (304-gram) mass. Affix a small strip of double-coated adhesive tape to the magnetic side of the tape 1 inch (25.4 mm) above the weight. Slowly and uniformly rotate the tube so that the tape, held in tension by the weight, winds uniformly around the tube into a compact and even roll. The double-coated tape when wound into the roll acts to secure the end and prevent unwinding when the weight is removed. The tube supporting the weight is then exposed to the following temperature and humidity cycle:

Time (hr)	Temperature °F	Temperature °C	Relative Humidity (%)
16–18	130	54.4	85
4	130	54.4	10 or less
1–2	70	21.1	45

5.1.9.4 Results. To evaluate the tape for adhesion, the end of the roll shall be opened and the sticky tab removed. The free end of the tape shall then be held and the cylinder allowed to fall, thereby unwinding the tape. The unwound tape shall then be checked for coating delamination with the exception of the last 2 inches (51 mm) of tape nearest the cylinder.

5.1.10 Tape Cupping

5.1.10.1 Definition. The departure across a tape (transverse to motion) from a flat surface is defined as cupping.

5.1.10.2 Requirement. The departure from a flat surface shall not exceed 0.015 inch (0.38 mm).

5.1.10.3 Procedure. Cut a tape length of 0.248 inch (6.30 mm) and place the cut tape concave side down on a flat surface. Measure the departure from the surface for a minimum of 1 hour after cutting.

5.1.11 Tape Light Transmission

5.1.11.1 Definition. Tape light transmission refers to the measure of light reflected by the mirror and transmitted through the plastic cover and tape.

5.1.11.2 Requirement. The tape shall have a light transmittance of less than 0.5% measured by means of each of the following light sources when using a silicon photodiode for detection:

(1) A tungsten lamp having a color temperature of 2000°K ± 200°K

(2) A light-emitting diode having a peak output at 940 nanometers ± 50 nanometers

5.1.11.3 Test Procedure

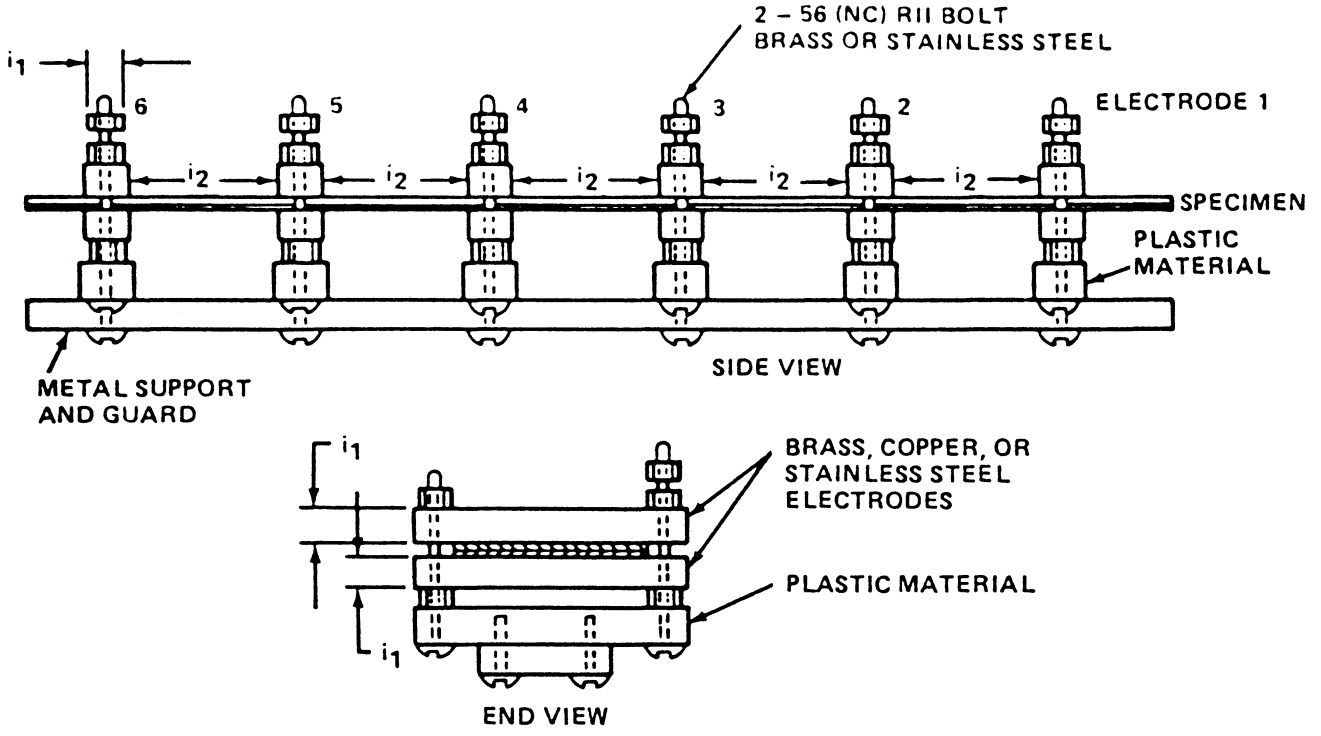
5.1.11.3.1 Test Fixture. Tape light transmittance shall be measured using an LED light source of 940 nanometers ± 50 nanometers and a silicon photodiode for detection, as shown in the fixture depicted by Figure 5.

5.1.11.3.2 Test Circuit. The measurement of transmittance shall be made using the test circuit shown in Figure 6, assuring that the photodiode is operating in the linear region (that is, not saturated) when no tape is in place between the aperture and the mirror.

5.1.11.3.3 Light Transmittance Measurement. The light transmittance shall be as follows:

$$\frac{E_{out}\ (\times\ 100\ \text{Range, Tape in Place})}{E_{out}\ (\times\ 1\ \text{Range, No Tape})}\ \%$$

The maximum light transmittance, as it applies to this standard, shall be the maximum value measured in the two zones: BOT to LP and EW to EOT. The measurement shall include the optical effects of the plastic cover and mirror.



Dimension	Inches	Millimeters
i_1 (3X)	0.250	6.35
i_2 (5X)	0.500	12.70

Figure 3
Resistance Measurement Electrodes for Tape

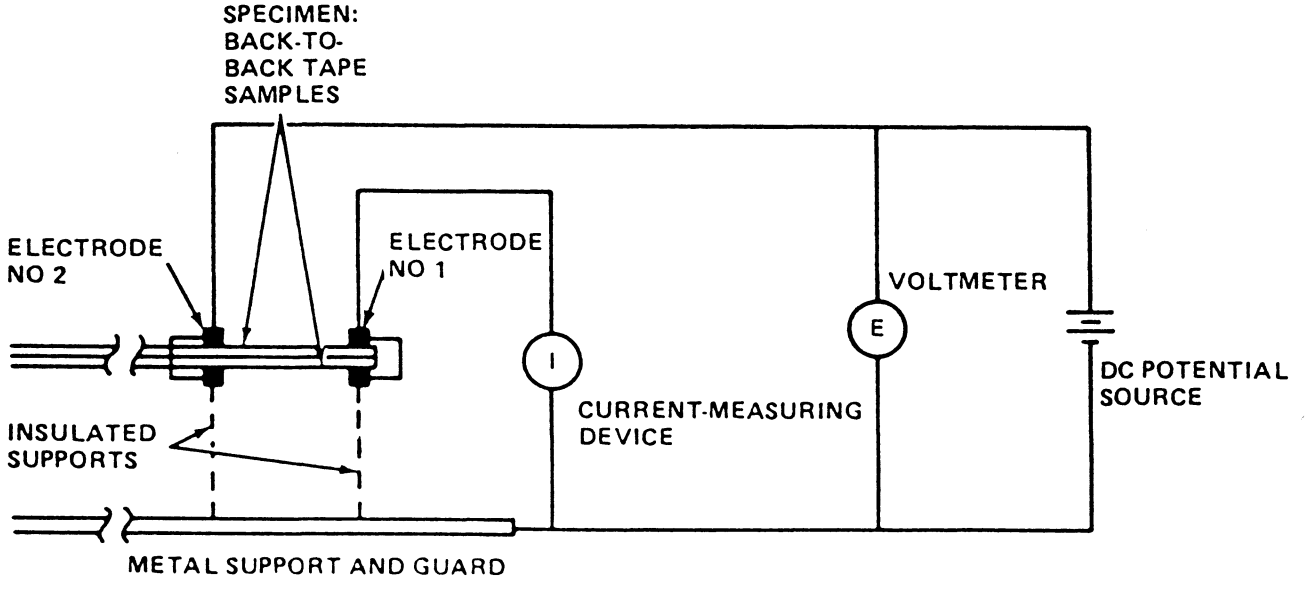
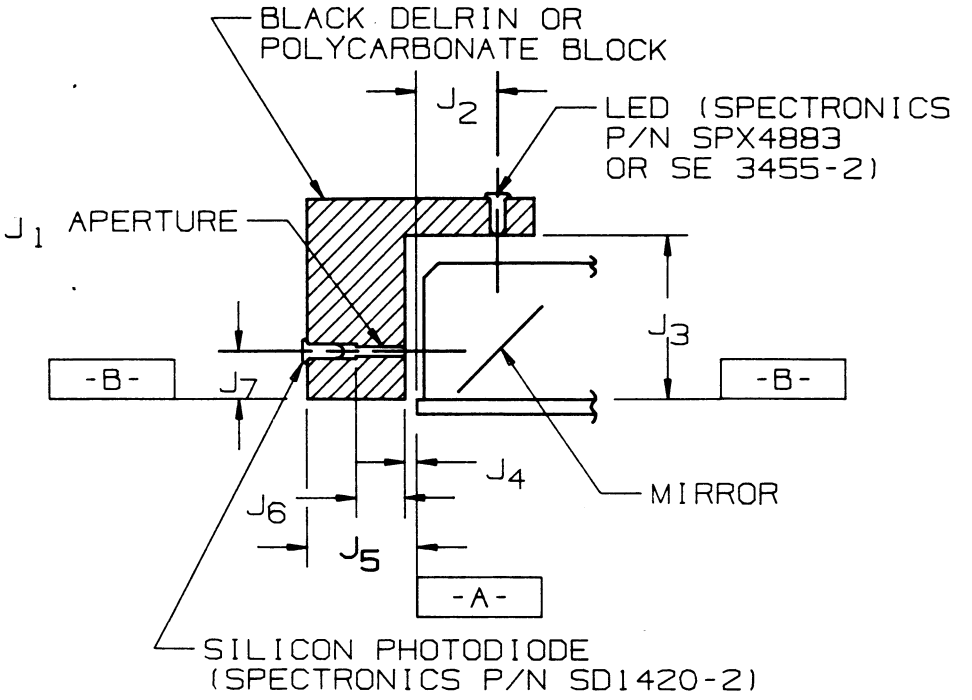


Figure 4
Resistance Measurement Circuit for Tape



Dimension	Inches	Millimeters
J_1	0.060 ± 0.002*	1.52 ± 0.05*
J_2	0.286	7.26
J_3	0.634	16.10
J_4	0.066	1.68
J_5	0.050	1.27
J_6	0.130	3.30

*Diameter

NOTE: All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

Figure 5
Light Transmission Test Fixture for Tape

5.2 Tape Recording Properties. The magnetic properties of the tape are defined by the testing requirements given in this section. When the tests are being performed, the output or resultant signal shall be measured on the same relative pass for both the signal amplitude reference tape and the tape under test (read-while-write, or on equipment without read-while-write capability, on the first forward read pass) on the same equipment.

5.2.1 Defect Density

5.2.1.1 Definitions

5.2.1.1.1 Threshold Level (TL). The TL is measured relative to the standard reference amplitude and is expressed as a percentage.

5.2.1.1.2 Track Width (TW). The TW is the width of recorded signal sensed by the read head.

5.2.1.1.3 Tested Surface Area. The tested surface area is that surface containing recorded signals exclusive of erased gaps or other nonused recording areas in which errors are not detectable.

This tested surface area is the product of TW and the total length of data track areas tested.

5.2.1.1.4 Rejected Region. A rejected region is any 1.0-inch (25.4-mm) length of tested track containing one or more missing pulses. A missing pulse is defined as any head-to-tape separation, or anomaly in the oxide surface, that produces a loss of amplitude in the playback signal below TL.

5.2.1.1.5 Defect Density. The number of rejected regions observed, divided by the tested surface area, is the defect density. It is expressed as defects per square inch (D/in^2) or defects per square millimeter (D/mm^2).

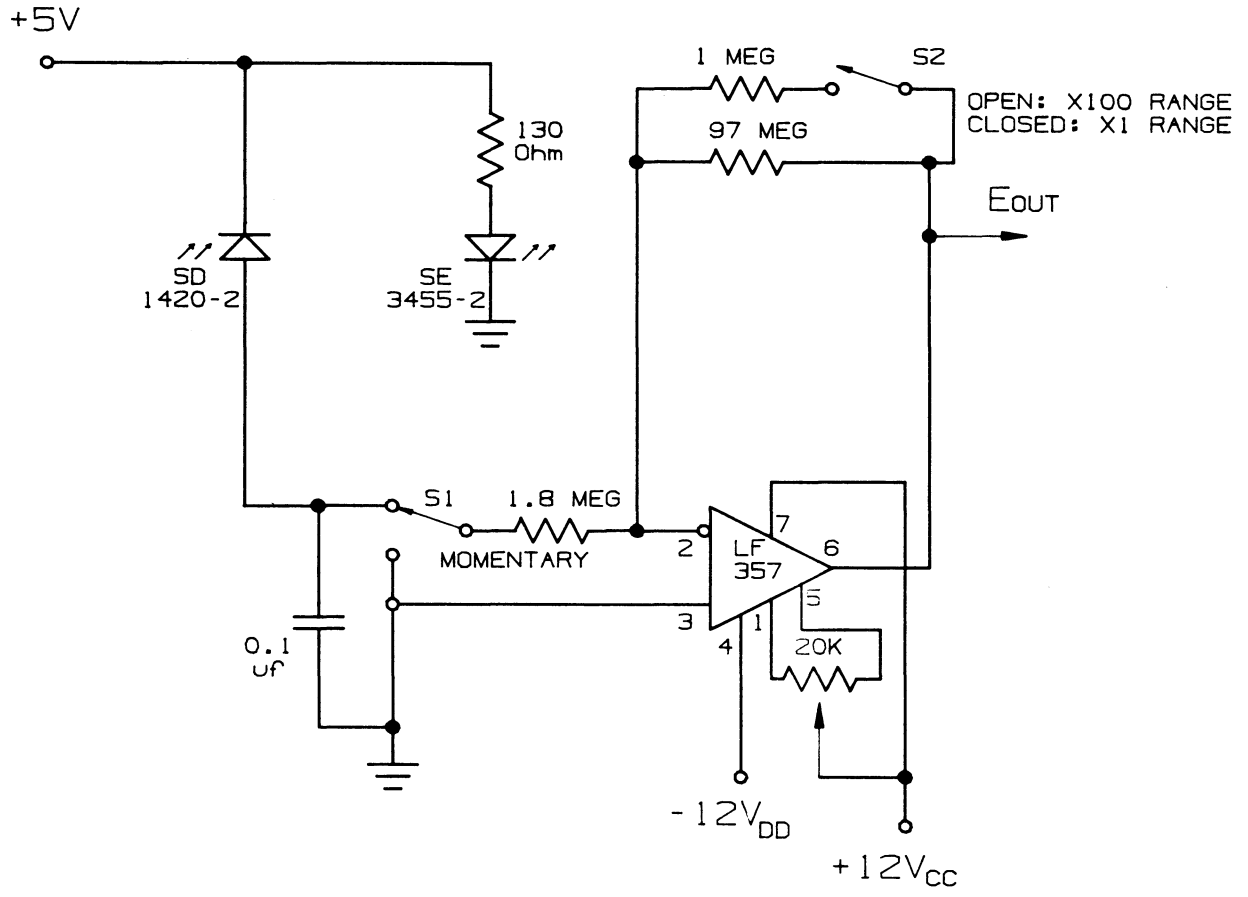


Figure 6
Light Transmission Test Circuit for Tape

5.2.1.1.6 Effective Defect Diameter (EDD). The EDD is defined as follows:

$EDD = (1 - TL/100) \times TW$

5.2.1.2 Requirement. The defect density shall be less than or equal to:

$22\, e^{(-490\ EDD)}\ D/in^2\ (0.0341\, e^{(-19.3\ EDD)}\ D/mm^2)$

5.2.1.3 Procedure. Perform the test in contact over the tested surface area at 10 000 ftpi (394 ftpmm).

5.2.2 Ease of Erasure. The maximum signal level remaining after subjecting a tape recorded at 1600 ftpi (63 ftpmm) with the test recording current (as specified in 2.4 of ANSI X3.55-1982) to a longitudinal steady field of 1000 oersteds (79 600 A/m) shall be 3 percent of the standard reference amplitude.

5.2.3 Average Signal Amplitude. The average peak-to-peak signal amplitude of the tape under test shall not deviate from the standard reference amplitude by more than ± 25 percent at 6400 ftpi (252 ftpmm) and 10 000 ftpi (394 ftpmm). The averaging shall be done over a minimum of 1.0 inch (25.4 mm).

The tape under test and the signal amplitude reference tape cartridge shall be recorded on the same equipment using the appropriate test recording current. The output level shall be measured on a centrally located track on the same equipment.

6. Cartridge

6.1 General Description. The cartridge is a compact coplanar design with the tape and hubs completely enclosed by the case, except for belt capstan and head openings. The tape is driven by means of a tensioned belt, which is driven by the internal belt capstan that receives motion from an external motor (see Figure 1). Tape guides are located inside the cartridge. A clear plastic top allows visual monitoring of the tape.

6.1.1 Dimensions. The dimensions of the cartridge are as shown in Figure 7.

6.1.2 Positioning Planes. The cartridge shall be referenced to the read/write machine only in the cross-hatched areas shown in Figure 8. The application of forces, suggested in Figure 8, is one method of assuring conformance of the cartridge to the positioning plane.

6.1.3 Attachment. The ends of the tape shall not be attached to the hubs.

6.1.4 Mounting Position. The cartridge is intended to mount in read/write machines in one position only, and cartridges shall have asymmetrical features that can be utilized to prevent engaging the cartridge improperly (see Figure 7).

6.1.5 Light Sense. The cartridge shall contain optical elements to permit photoelectric detection of the tape position holes (see Figure 9).

6.1.6 Cartridge-in-Position Sense. The cartridge shall have an area on the front surface that is held to dimensions as shown in Figure 10, to be used for sensing that the cartridge is in position for writing and reading.

6.1.7 Door. The cartridge shall have a door for protection of the tape during storage and transport. Requirements for opening the door shall be as shown in Figure 11.

6.2 File Protect. The cartridge shall have an operator-rotatable plug to prevent writing or erasing the tape. Devices using the cartridge shall be designed to prevent writing or erasing the tape when the plug is rotated to indicate "safe" (see Figure 10 for the file protect plug location).

6.3 Physical Labels

6.3.1 Location and Size. The rear surface of the cartridge, opposite the exposed tape, and a portion of the top side of the cartridge may be used for labels. The rear surface area provides for readability of the label when it is in a stacked or inserted position. Position and size of the label shall be within the provided depression of the label area as shown in Figure 12.

6.3.2 Interchange Information. Suitable labels shall be used for marking contents of cartridges. The use of pencil or erasable material is not recommended.

6.4 Tape Guides. The tape shall be guided by two tape guides contained within the cartridge (see Figure 13). The read/write machine shall not contain any elements to restrict the tape path in the transverse direction.

6.5 Speeds. The operating speed range for the cartridge tape is 30-90 in/s (0.76-2.29 m/s).

6.6 Driving Force. The tangential force required at the external driving surface of the belt capstan to maintain a constant operating speed shall be at least 1.0 ozf (0.28 N), but not more than 4.5 ozf (1.25 N). The external radial load applied to the belt capstan when making this measurement shall be 20 ozf ± 2 ozf (5.57 N ± 0.56 N). The measurement shall be taken when the cartridge is driven at constant speed and a low friction contact surface (coefficient of friction is less than 0.1) located where the head would be located when the tape cartridge is inserted in a drive.

6.7 Total Inertia. The total equivalent inertial mass of all cartridge elements, as referred to the outer surface of the belt capstan, shall not exceed 0.0022 ozf • s^2 / inch (24 grams) in linear units.

6.8 Dynamic Response

6.8.1 Definition. Dynamic response refers to the velocity response of tape motion to a step-driving function applied to the belt capstan.

6.8.2 Requirement. The natural resonant frequency shall be a minimum of 60 Hz.

6.8.3 Procedure. A drive capable of producing a pronounced overshoot of the tape velocity should be used. The drive servo should be critically damped so that the overshoot observed is not that of the drive. The reciprocal of the time measured between the first two overspeed peaks is the natural resonant frequency.

6.9 Tape Tension

6.9.1 Definitions

6.9.1.1 Tape Tension. Tape tension is the resultant force in the longitudinal direction of the tape on a cross-section taken through the tape perpendicular to the longitudinal direction.

6.9.1.2 Instantaneous Tension. Instantaneous tension is the tension as measured at the cross-section of the tape located at the head position of the free tape path and averaged over 10 milliseconds.

6.9.1.3 Average Tension. Average tension at a point along the length of the tape is the average value of the instantaneous tension measured over 3 feet (1 meter) of tape symmetrically located around that point.

6.9.1.4 Dynamic Tension. Dynamic tension at a point along the length of the tape is the maximum variation of instantaneous tension over the 3 feet (1 meter) length of tape symmetrically located around that point.

6.9.1.5 Transverse Tension Variation. The transverse tension variation is that variation across the tape produced by differences in the path length of the free tape between the two edges of the tape.

6.9.2 Requirements

6.9.2.1 Value of Instantaneous Tension. The instantaneous tension at any point along the length of tape between LP and EW shall be:

(1) Between 1.0 ozf (0.28 N) and 3.5 ozf (0.98 N) in the testing environment.

(2) Between 0.5 ozf (0.14 N) and 4.0 ozf (1.12 N) in the operating environment. When the temperature is brought back to that of the testing environment, the requirements of 5.9.2.1(1) shall be met.

6.9.2.2 Value of Dynamic Tension. The dynamic tension at any point along the length of the tape between LP and EW shall not exceed 0.75 ozf (0.21 N).

6.9.2.3 Requirement for Transverse Tension Variation. The test rod shall not deviate from the horizontal by more than 4° at any point along the length of tape from LP to EW.

6.9.3 Procedures

6.9.3.1 Procedure for Measuring Instantaneous Tape Tension

6.9.3.1.1 Conditioning. The tape shall be conditioned before testing by winding it at 90 in/s (2.29 m/s) from BOT to EOT, and then back to BOT.

6.9.3.1.2 Tape Speed. The tape speed during testing shall be 30 in/s (0.76 m/s).

6.9.3.1.3 Position of the Measuring Transducer. When positioning the measuring transducer, the following requirements shall be observed:

(1) The measuring transducer shall be positioned at the point along the free tape path at which the head would be located if the cartridge were mounted in a drive.

(2) When inserted in the tape path, the transducer shall cause an increase in the length of the tape path within the limits described in 6.17.

(3) The transducer shall be perpendicular to reference plane B within ± 1°.

6.9.3.1.4 Characteristics of the Measuring Transducer. The following characteristics shall be observed:

(1) The coefficient of friction of the bearing surface shall be less than 0.1.

(2) The upper limit of its frequency response shall be at least 100 Hz.

(3) The width of the bearing surface shall be sufficient for it to be in contact with the whole width of the tape.

6.9.3.2 Test Procedure for Measuring Transverse Tape Tension Variation

6.9.3.2.1 Conditioning. The tape shall be conditioned before testing by winding it at 90 in/s (2.29 m/s) from BOT to EOT, and then back to BOT.

6.9.3.2.2 Position of Tape for Measurement. When positioning the tape, the following requirements shall be observed:

(1) The cartridge shall be held with reference plane B vertical and the cartridge door on top and in the open position.

(2) The tape shall remain stationary at the selected point.

6.9.3.2.3 Characteristics of the Transverse Tape Tension Test Rod. The following characteristics shall be observed:

(1) The form and dimensions of the test rod shall be as given in Figure 14.

(2) The weight of the test rod shall be 0.5 ozf (0.14 N).

(3) The center of gravity shall be within 0.005 inch (0.13 mm) of the center of the notch.

6.9.3.2.4 Position of the Test Rod. The slot of the test rod shall be centered over the point along the free tape path length at which the head would be located if the cartridge were mounted in a drive.

6.10 Drive Ratio. The ratio of the tape velocity to the surface velocity of the belt capstan shall be 0.76 ± 0.02.

6.11 Electrical Resistance of the Belt Capstan

6.11.1 Definition. The electrical resistance of the belt capstan refers to the measurement of the bulk resistance of the belt capstan.

6.11.2 Requirement. The electrical resistance of the belt capstan shall not exceed 1 megohm.

6.11.3 Procedure. The procedure to test the electrical resistance of the belt capstan shall be as follows:

(1) Ensure that the contact surfaces of the belt capstan and the test fixture are clean and free from oil, grease, tarnish, or other contaminants before making the test (see Figure 15).

(2) Place the belt capstan on the centering pin of the bottom contact surface, with the gate area over the relief.

(3) Place the upper contact surface on top of the belt capstan, centered over the inner hub relief, and apply a force of 6 lbf (26.6 N) centrally over the capstan.

(4) Measure the current flowing in the circuit when a potential of 500 volts ± 5 volts is applied.

6.11.4 Test Result. The current shall be 0.40 milliampere, minimum.

6.12 Instantaneous Speed Variation (ISV)

6.12.1 Definition. An instantaneous speed variation event is said to have occurred whrn the residual time displacement error (TDE) exceeds 156 nanoseconds when measured at 30 in/s (0.76 m/s) and 6400 ftpi (252 ftpmm).

6.12.2 Requirement. The number of ISV events shall be a matter of agreement between the parties concerned.

6.12.3 Procedure

6.12.3.1 General. When a tape is recorded at constant frequency, F_0, and played back, the frequency of the recovered signal is not constant, but shall be in general $F_0 \pm \Delta F$.

$\Delta F/F_0$ is defined as the instantaneous speed variation (ISV) and can be resolved into a series of frequency components $f_1, f_2, \ldots, f_K$ each of magnitude $\alpha_1, \alpha_2, \ldots, \alpha_K$, that is:

$$\sum_{i=1}^{K} \alpha_i \sin 2\pi f_i t .$$

Owing to this ISV, any flux transition is not in its expected time location, but exhibits a shift (Δt). This shift is defined as time displacement error (TDE). It can be shown that, for any given component of ISV, the resultant TDE is:

$$\frac{\alpha_i}{2\pi f_i} \sin 2\pi f_i t,$$

with a peak value of $\alpha_i/2\pi f_i$. A data separator phase-locked loop normally follows the TDE and reduces it to some residual value (Residual TDE). The degree of reduction (suppression) is equal to $(1 + G)°$, where G is the open-loop gain at the frequency of interest.

Hence, residual TDE for a given frequency is:

$$\text{TDE}_R = \frac{\alpha_i}{2\pi f_i} \cdot \frac{1}{1 + G_i}.$$

For the purpose of defining allowable TDE for interchange, a standard phase-locked loop gain of the form:

$$G = \left(\frac{f_n}{jf}\right)^2 \cdot \left(1 + j\sqrt{2}\frac{f}{fn}\right)$$

should be established, leading to a suppression function of:

$$\frac{1}{1+G} = \frac{(jf/f_n)^2}{1 + j\sqrt{2}f/f_n + (jf/f_n)^2}.$$

The magnitude of the suppression function is:

$$\frac{1}{|1+G|} = \frac{(f/f_n)^2}{\sqrt{(1-(f/f_n)^2)^2 + 2(f/f_n)^2}}.$$

This is shown as a function of frequency in Figure 16.

NOTES:
(1) $f_n = F_{0/17}$.
(2) For tape speeds other than 30 in/s (0.76 m/s), the natural frequency of the loop may be scaled linearly.
(3) The maximum allowable single-frequency ISV that would result in a value of TDE within the specification is shown in Figure 17.

6.12.3.2 Test Circuit. The standard loop shall be designed as detailed in Figure 18.

$$\frac{K_1 K_2}{CR_1} = (2\pi f_n)^2$$
$$= 1.25 \times 10^9$$
$$CR_2 = \frac{1}{2\pi \times 4 \times 10^3}$$
$$\text{TDE}_{out} = \frac{1}{K_1 F_0} \text{ s/volt}$$
$$F_0 = 96 \text{ kHz}.$$

6.12.3.3 Test Method. The following test method shall be used:

(1) Record the tape with a constant recording density of 6400 ftpi (252 ftpmm) full length, two tracks.

(2) Read the tape signals at 30 in/s (0.76 m/s), using a square wave output from the read channel connected to the input of the standard loop.

(3) Count the TDE events that exceed 156 ns (3% of the nominal flux transition spacing at 6400 ftpi [252 ftpmm]).

NOTE: TDE events within 0.5 inch (13 mm) shall be considered as a single event. TDE events caused by missing pulses shall be ignored.

6.13 Low-Frequency Speed Variation. Cartridge-induced ISV shall not exceed 4 percent within the band of 0-1000 Hz. The ISV measured shall encompass discrete and combinations of frequency products within that band.

6.14 Acceleration. The cartridge shall be capable of withstanding acceleration and deceleration of the linear tape speed of 2000 in/s² (50.8 m/s²).

6.15 Dynamic Tape Skew

6.15.1 Definition. Dynamic tape skew is the variation of the angle that the centerline of the tape makes with reference plane B.

6.15.2 Requirement. The dynamic tape skew shall not exceed 7 minutes of arc.

6.15.3 Procedure. The following procedure shall be used:

(1) Write flux transitions on two test tracks over the entire recording area of the tape at speed v.

(2) Using the same two gaps, read the tape in the forward and reverse directions, measuring the time differences between corresponding flux transitions.

6.15.4 Results. The maximum time difference t and the distance d between the centerlines of the two test tracks are used to calculate the dynamic tape skew, namely

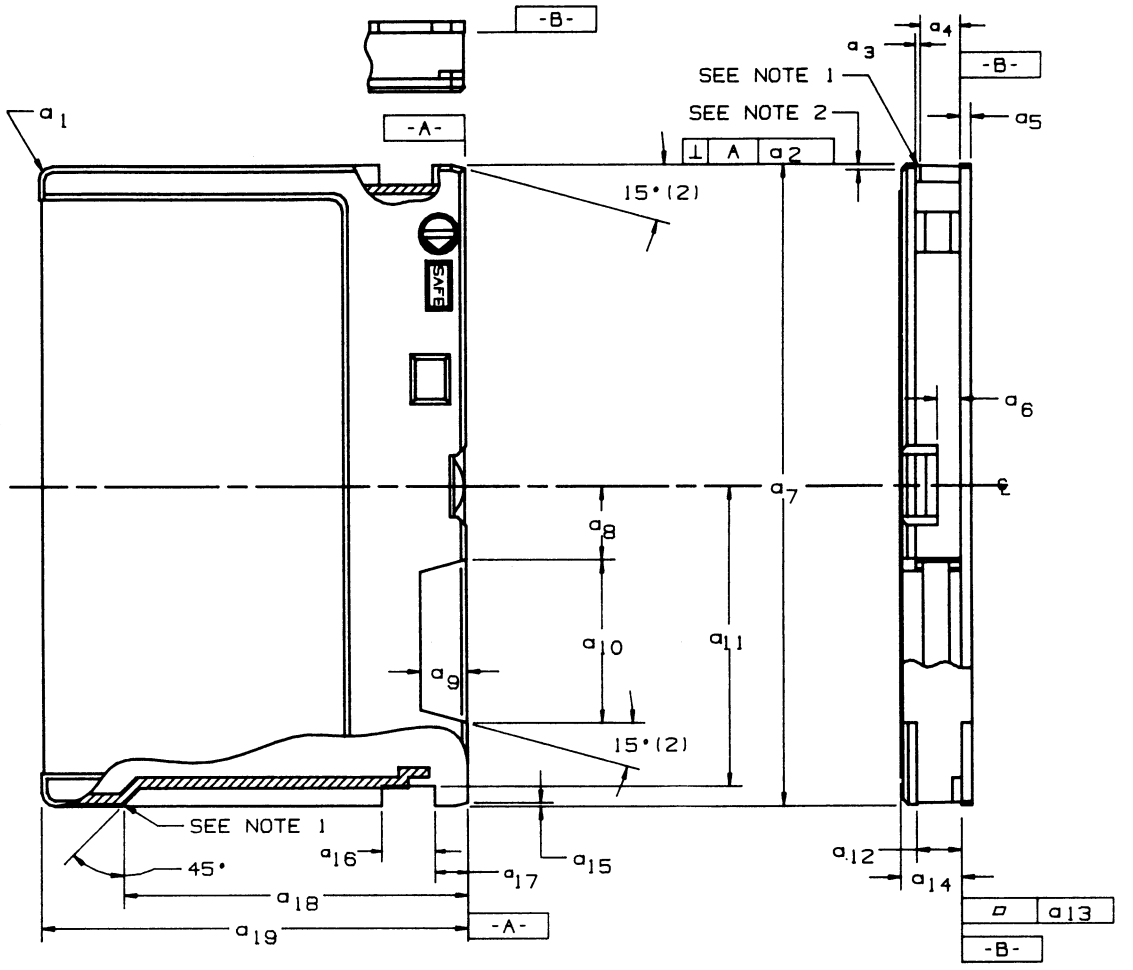
$$\arctan(t \cdot v/d) \leqslant 7'.$$

6.16 Drop Test. The cartridge shall be able to withstand the shock incurred from falling 30 inches (0.76 meter) onto a concrete floor covered with asphalt tile. The cartridge shall be dropped once on one corner and once on the base. After the drops, the cartridge shall then meet all the requirements of this standard.

6.17 Head Penetration

6.17.1 Definition. Head penetration is the increase in the length of the tape path resulting from the deviation of the tape path from a straight line caused by the recording head(s) or other drive components when the cartridge is inserted in a drive.

6.17.2 Recommendation. To assure reliable tape handling and to avoid tape damage, the head penetration should be greater than 0.015 inch (0.38 mm) and less than 0.055 inch (1.4 mm).



NOTES:

(1) Features required to prevent inserting cartridge improperly.

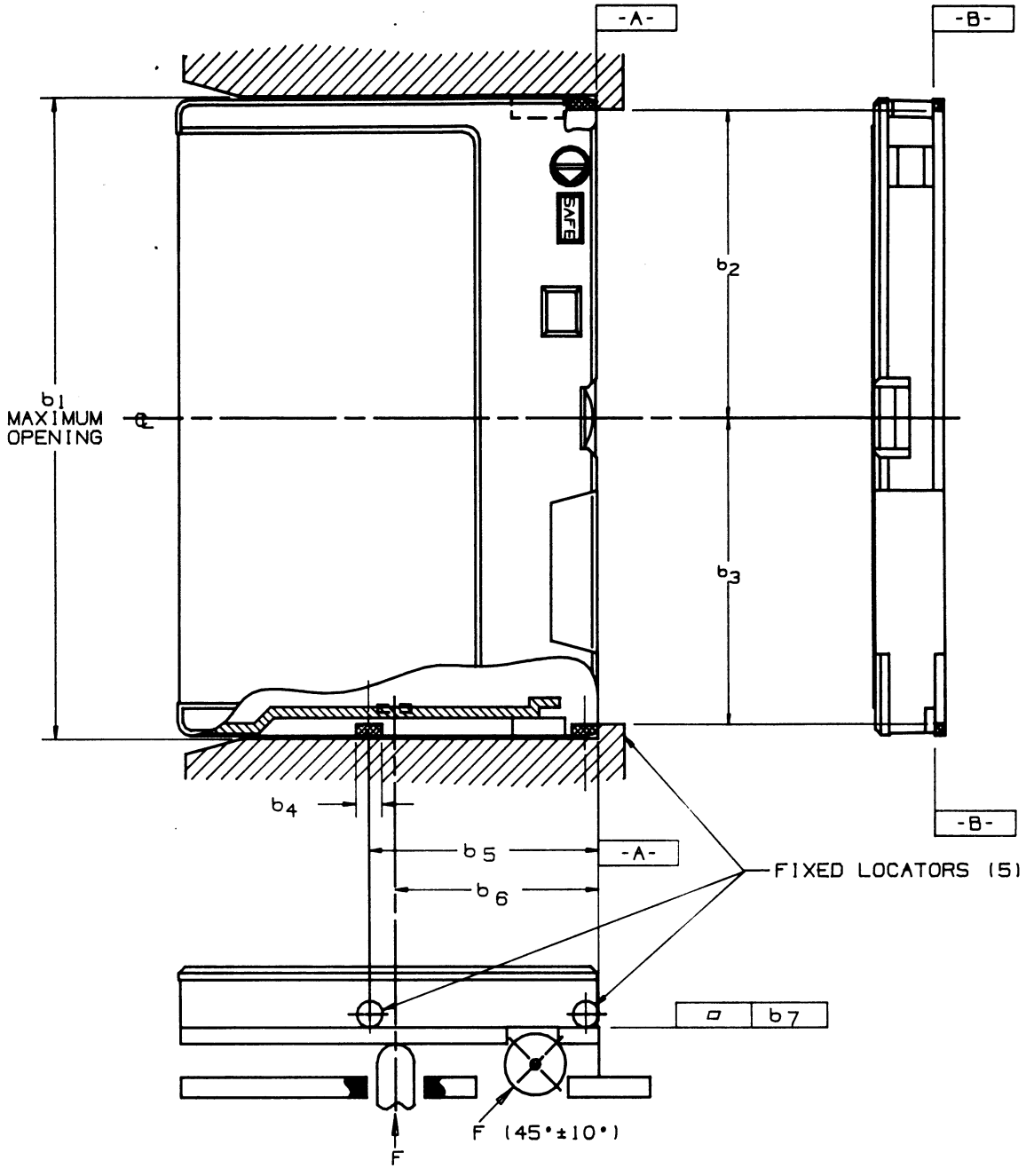
(2) Cover (top edge) shall not extend beyond base at datum -A- (front) or its opposite side (rear). The remaining two sides may extend beyond base 0.005 inch (0.13 mm) maximum, except at notches, but must be within dimension a_7.

(3) All tolerances except where otherwise noted are 0.005 inch (0.13 mm) <0.5°.

Dimension	Inches	Millimeters
a_1	0.125*	3.18*
a_2	0.005	0.13
a_3	0.050	1.27
a_4	0.375	9.52
a_5	0.100 ± 0.003†	2.54 ± 0.08†
a_6	0.218 ± 0.010	5.54 ± 0.25
a_7	6.000	152.40
a_8	0.687	17.45
a_9	0.437	11.10
a_{10}	1.531	38.89
a_{11}	2.813	71.45
a_{12}	0.425	10.80
a_{13}	0.010	0.25
a_{14}	0.575‡	14.61‡
a_{15}	0.033	0.84
a_{16}	0.500	12.70
a_{17}	0.312	7.92
a_{18}	3.218 .	81.74
a_{19}	4.000	101.60

*Radius
†Base material thickness
‡Maximum

Figure 7
Dimensions of Cartridge



NOTES:

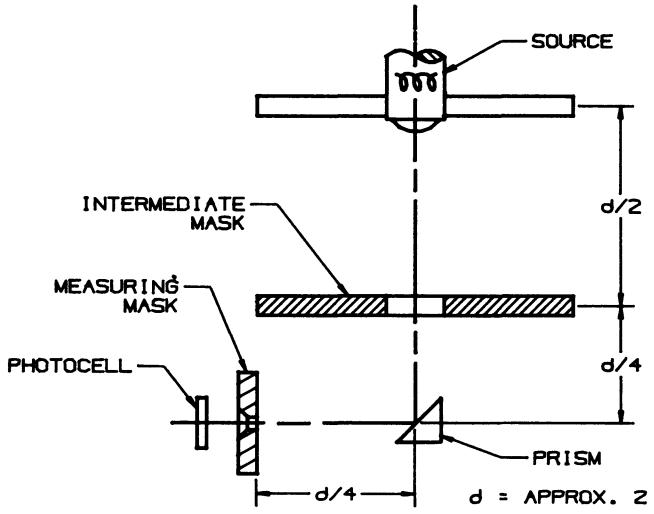
(1) Fixed locators (2X) along surface [-A-] defined as datum [-A-].

(2) b_4 (3X) indicates cartridge plane locations defined as datum [-B-].

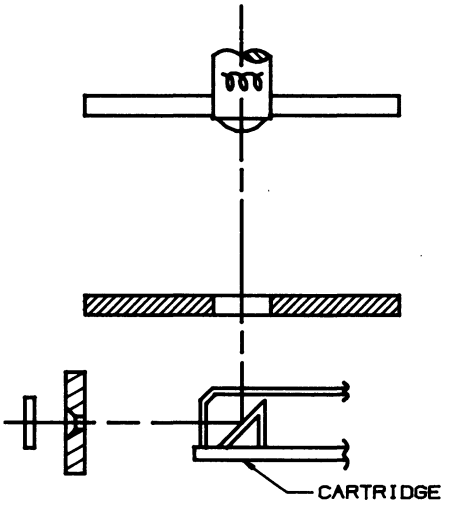
(3) All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

Dimension	Inches	Millimeters
b_1	6.025	153.04
b_2	2.844	72.24
b_3	2.844	72.24
b_4 (3X)	0.250	6.35
b_5	2.180	55.37
b_6	1.937	49.20
b_7	0.010	0.25

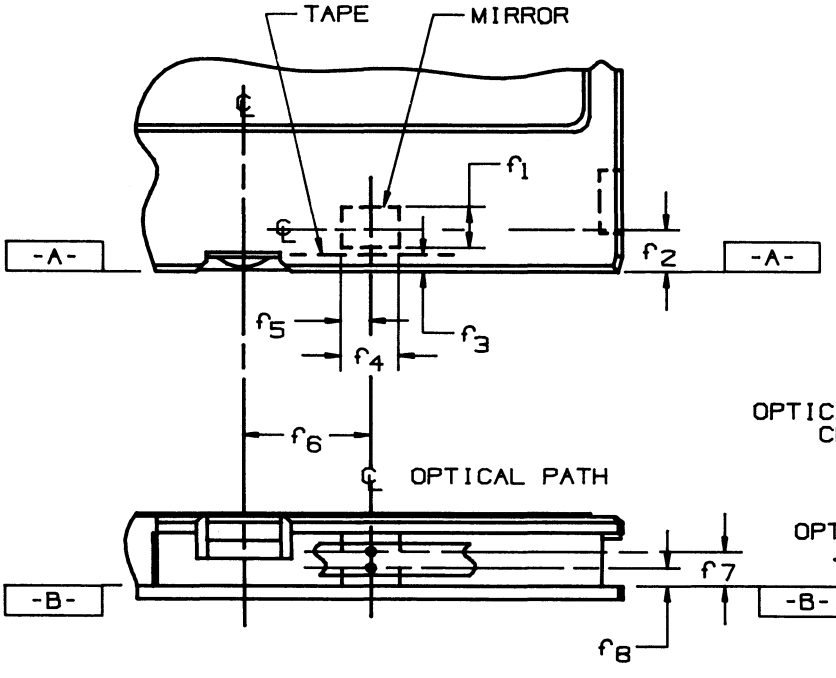
Figure 8
Locating Planes of Cartridge

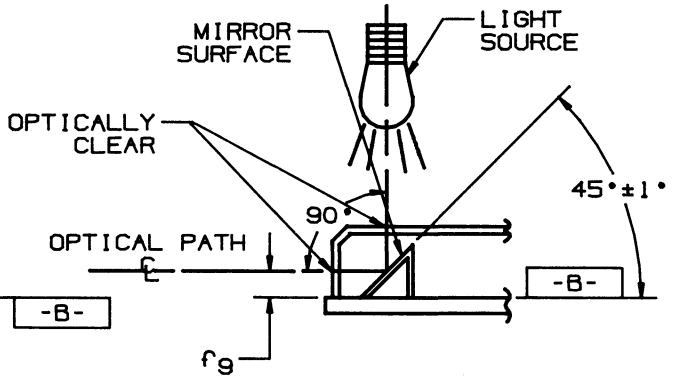


CALIBRATION CONFIGURATION



TEST CONFIGURATION





NOTES:

(1) Total optical transmission of both cover windows (including effects of reflection off mirror surface) to each of the following light sources shall be 50% minimum when sensed by a silicon photocell:

(a) 2000 ± 200 K tungsten lamp

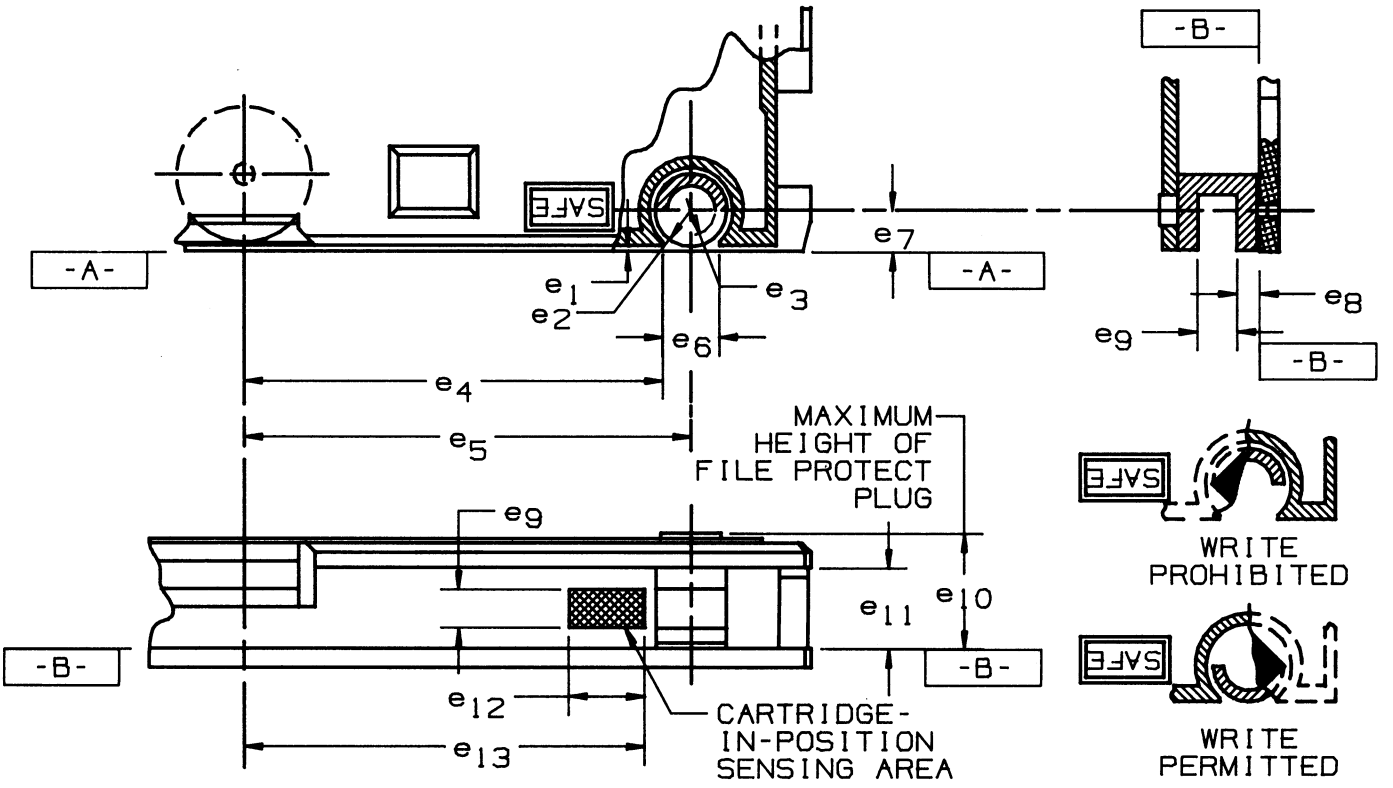
(b) 940 ± 50 nanometer LED

(2) Optical paths perpendicular to [-B-] plane reflected by the mirror at 90° through the tape position holes at f_6, f_7, f_8 shall not deviate from 90° by more than ±3° in all directions.

(3) All tolerances except where noted are ±0.005 inch (±0.13 mm).

Dimension	Inches	Millimeters
f_1	0.232	5.89
f_2	0.350	8.89
f_3	0.166	4.22
f_4	0.312	7.92
f_5	0.156	3.96
f_6	1.000	25.40
f_7	0.259 ± 0.008	6.58 ± 0.20
f_8	0.131 ± 0.008	3.33 ± 0.20
f_9	0.185 ± 0.010	4.70 ± 0.25

Figure 9
Light Sensing

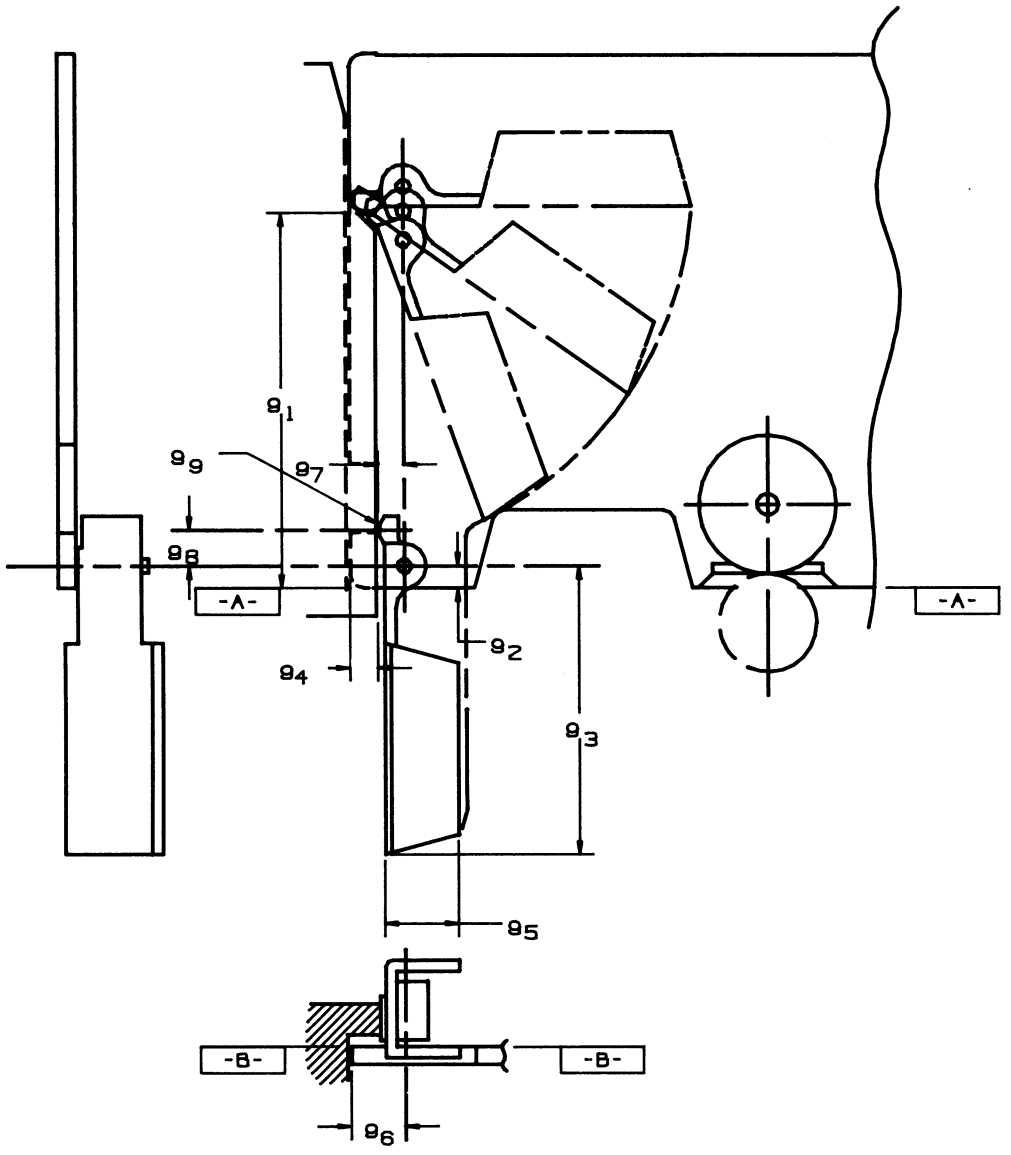


Dimension	Inches	Millimeters
e_1	0.035*	0.89*
e_2	0.250†	6.35†
e_3	0.187†	4.75†
e_4	2.172	55.17
e_5	2.359	59.92
e_6	0.375	9.52
e_7	0.250 ± 0.010	6.35 ± 0.25
e_8	0.107 ± 0.010	2.72 ± 0.25
e_9	0.250	6.35
e_{10}	0.585	14.86
e_{11}	0.425 ± 0.010	10.80 ± 0.25
e_{12}	0.500	12.70
e_{13}	2.140	54.36

*Maximum, cartridge-in-position sensing area.
†Radius

NOTE: All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

Figure 10
File Protect and Cartridge-in-Position Sense

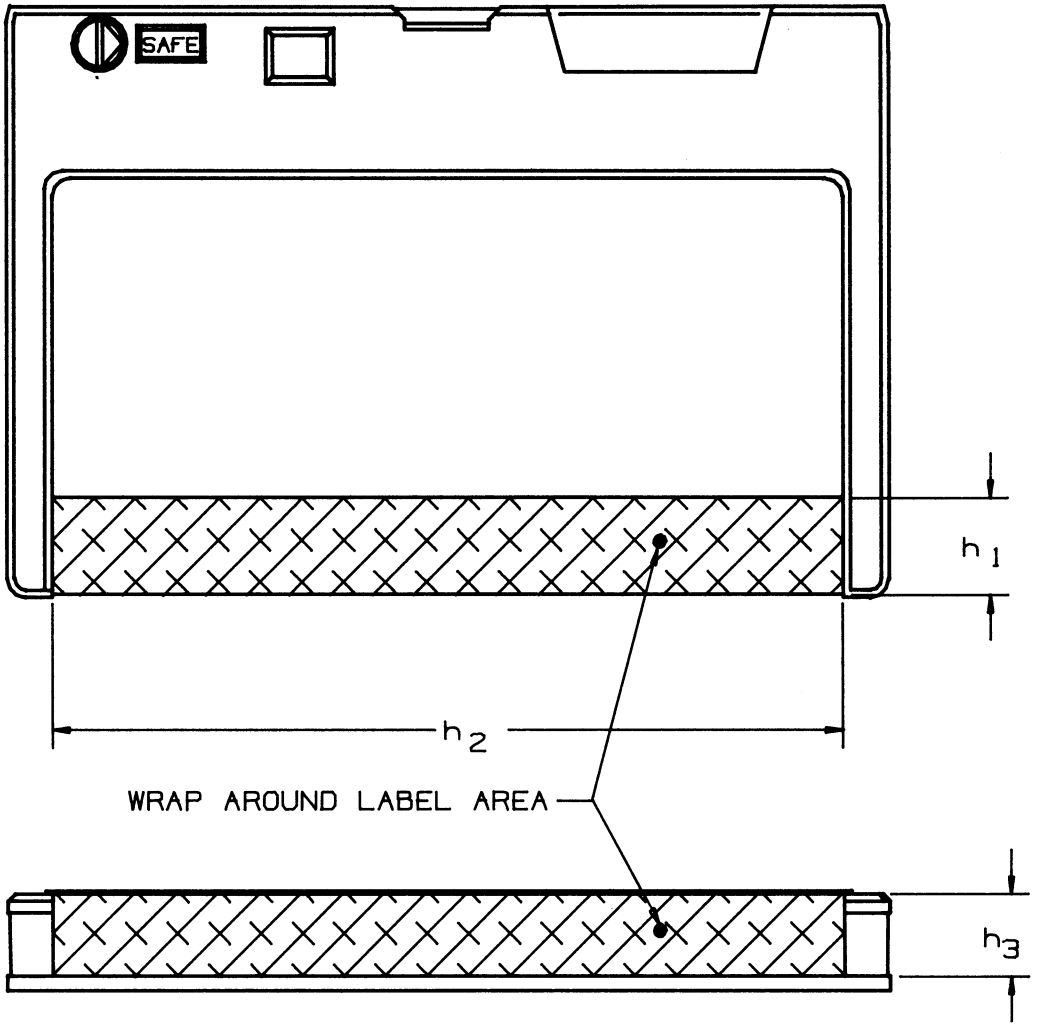


Dimension	Inches	Millimeters
g_1	2.350*	59.69*
g_2	0.187	4.75
g_3	$1.937^{+0.005}_{-0.010}$	$49.20^{+0.13}_{-0.25}$
g_4	0.160	4.06
g_5	$0.437^{+0.005}_{-0.010}$	$11.10^{+0.13}_{-0.25}$
g_6	0.360	9.14
g_7	0.200	5.08
g_8	0.268	6.81
g_9	0.125†	3.18†

*Minimum
†Radius

NOTE: All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

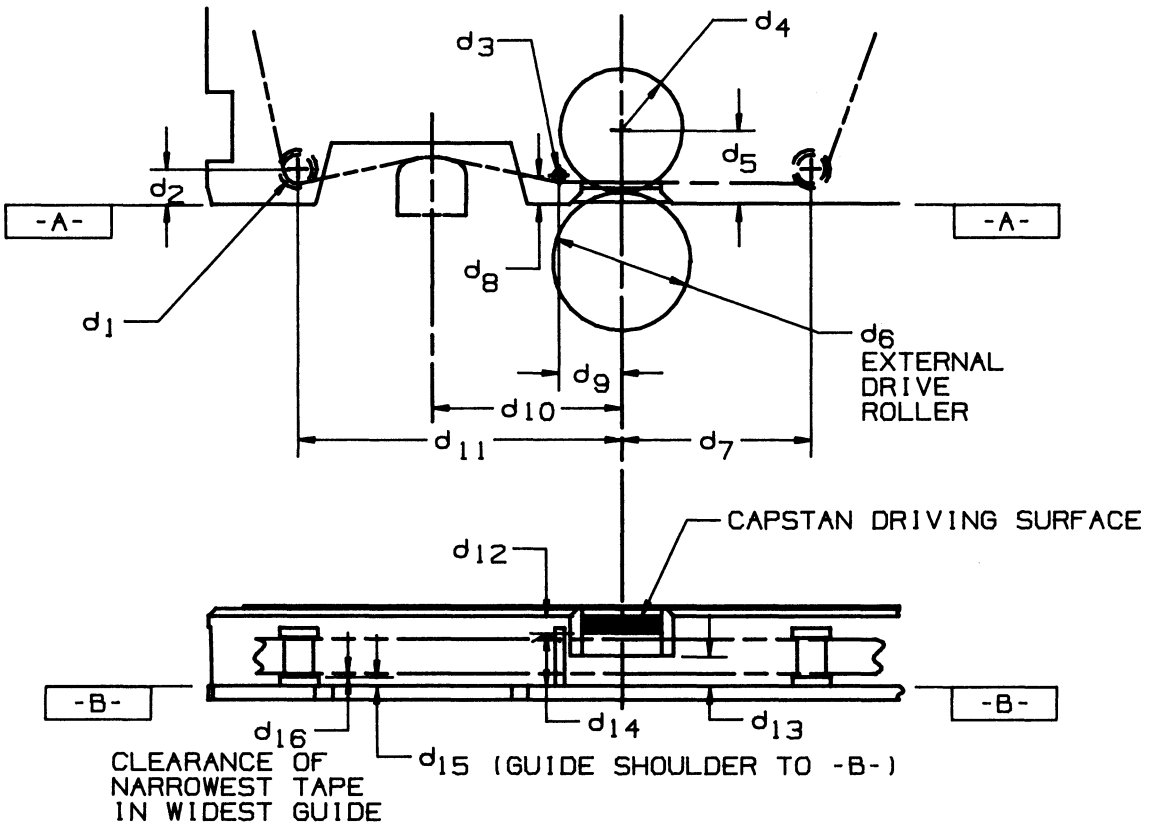
Figure 11
Profile of Cartridge Door



Dimension	Inches	Millimeters
h_1	0.656	16.66
h_2	5.375	136.52
h_3	0.500	12.70

NOTE: All tolerances are ±0.005 inch (±0.13 mm).

Figure 12
Label Area

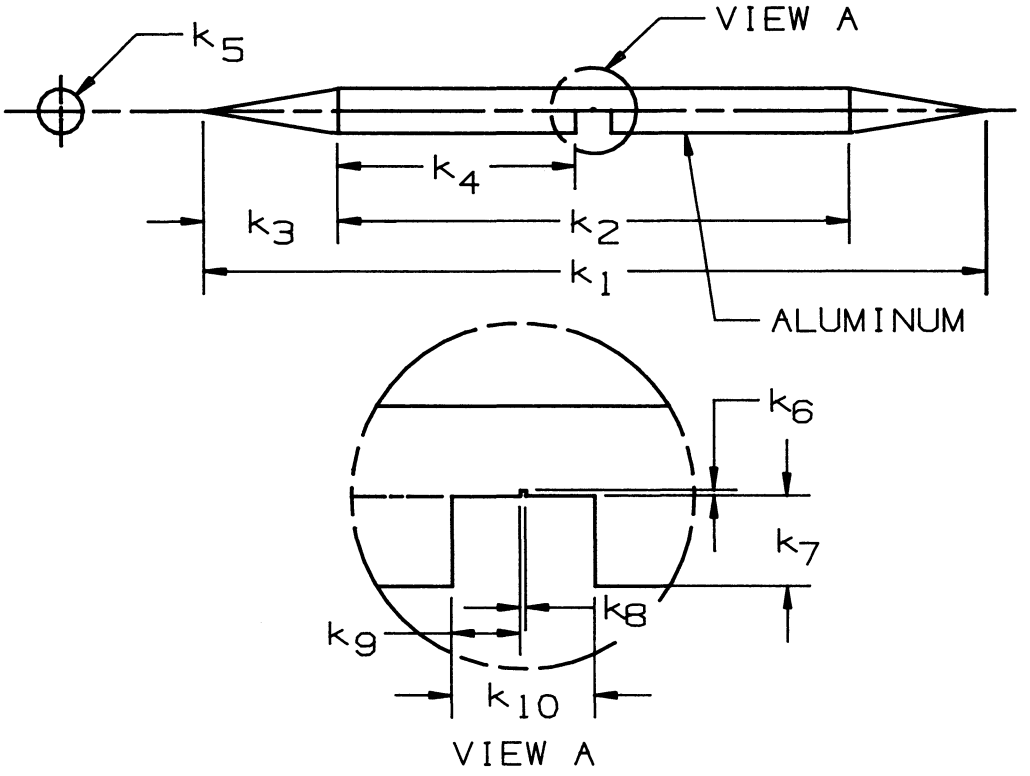


Dimension	Inches	Millimeters
d_1	0.210*	5.33*
d_2	0.250	6.35
d_3	0.094*	2.39*
d_4	0.445†	11.30†
d_5	0.531	13.49
d_6	1.000‡	25.40‡
d_7	1.375	34.92
d_8	0.203	5.16
d_9	0.453	11.51
d_{10}	1.375	34.92
d_{11}	2.343	59.51
d_{12}	0.125	3.18
d_{13}	0.218 ± 0.010	5.54 ± 0.25
d_{14}	0.338 ± 0.010	8.58 ± 0.25
d_{15}	0.070 ± 0.003	1.778 ± 0.076
d_{16}	0.004§	0.10§

*Diameter
†Radius
‡Maximum diameter
§Maximum

NOTE: All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

Figure 13
Dimensions of Tape Path and Drive



Dimension	Inches	Millimeters
k_1	5.450	138.43
k_2	3.574	90.78
k_3	0.938	23.82
k_4	1.662	42.21
k_5	0.312*	7.92*
k_6	0.010	0.25
k_7	0.156	3.96
k_8	0.011 ± 0.001	0.279 ± 0.025
k_9	0.119 ± 0.001	3.023 ± 0.025
k_{10}	0.249 ± 0.001	6.325 ± 0.025

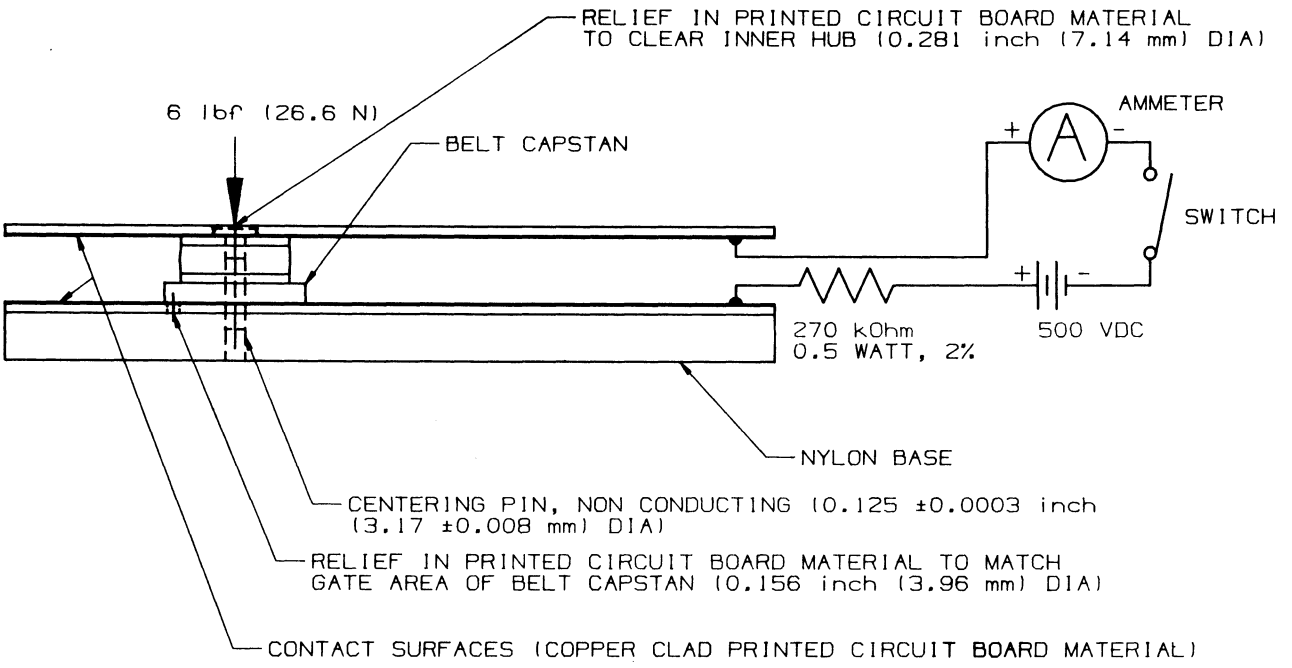
*Diameter.

NOTES:

(1) When notch is placed on a level edge 0.009 inch ± 0.001 inch (0.228 mm ± 0.025 mm) wide, bar shall balance with no noticeable lean.

(2) All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

Figure 14
Test Rod for Transverse Tape Tension



NOTE: All tolerances, except where otherwise noted, are ±0.005 inch (±0.13 mm).

Figure 15
Electrical Resistance Test Fixture for Belt Capstan

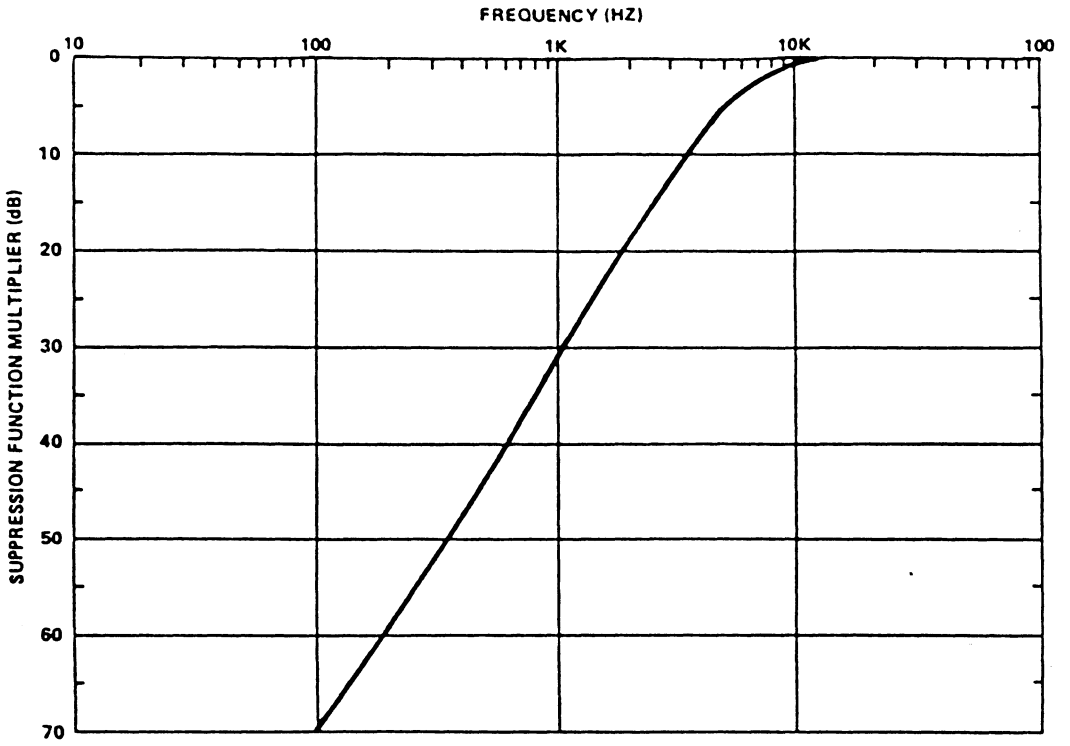


Figure 16
Phase-Locked Loop Suppression Function

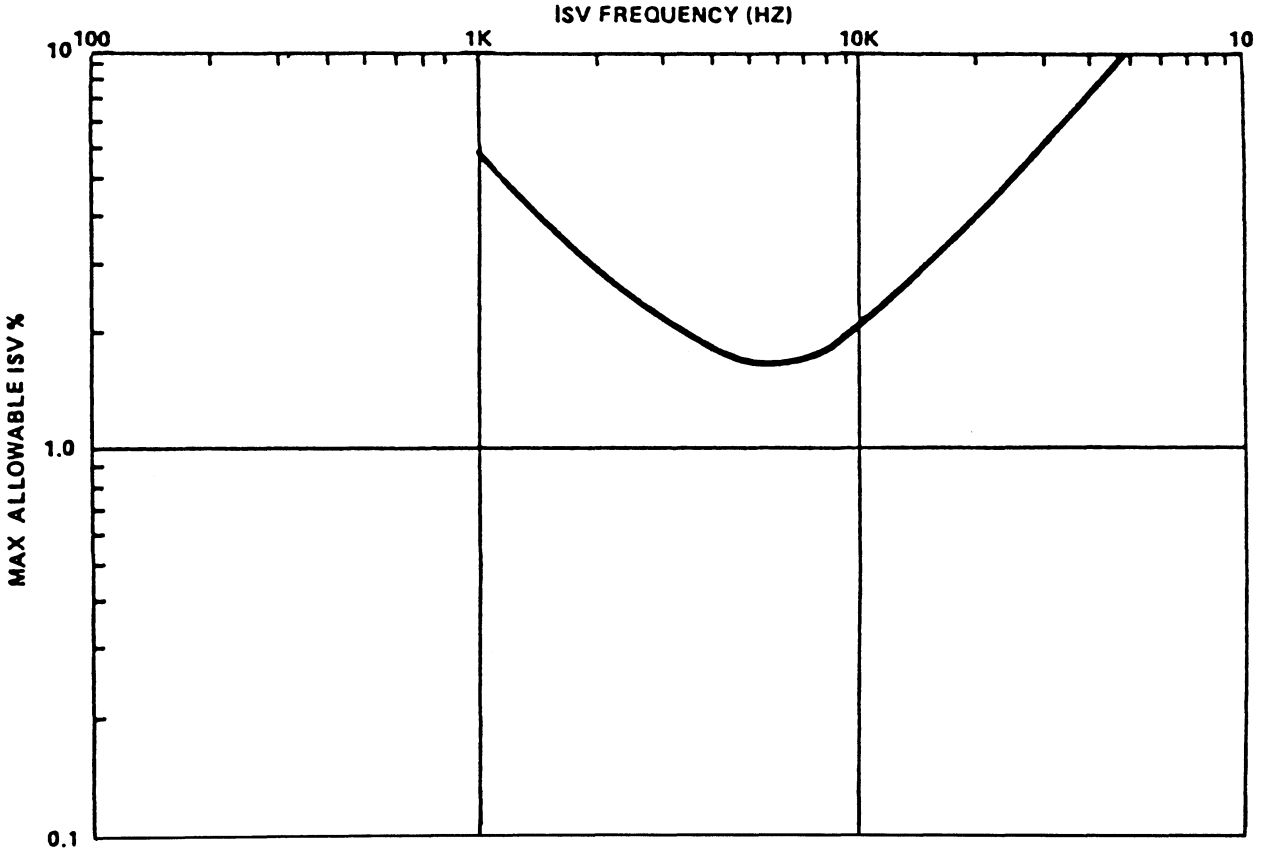


Figure 17
Maximum Allowable ISV

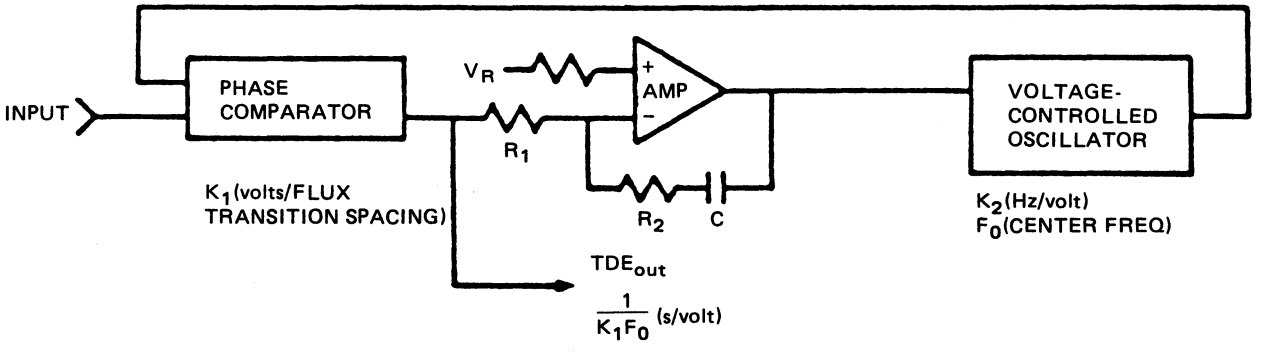


Figure 18
Standard Loop Block Diagram

American National Standards for Information

X3.1-1976 Synchronous Signaling Rates for Data Transmission
X3.2-1970 Print Specifications for Magnetic Ink Character Recognition
X3.4-1986 Coded Character Sets – 7-Bit ASCII
X3.5-1970 Flowchart Symbols and Their Usage
X3.6-1965 Perforated Tape Code
X3.9-1978 Programming Language FORTRAN
X3.11-1969 General Purpose Paper Cards
X3.14-1983 Recorded Magnetic Tape (200 CPI, NRZI)
X3.15-1976 Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission
X3.16-1976 Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.17-1981 Character Set for Optical Character Recognition (OCR-A)
X3.18-1974 One-Inch Perforated Paper Tape
X3.19-1974 Eleven-Sixteenths-Inch Perforated Paper Tape
X3.20-1967 Take-Up Reels for One-Inch Perforated Tape
X3.21-1967 Rectangular Holes in Twelve-Row Punched Cards
X3.22-1983 Recorded Magnetic Tape (800 CPI, NRZI)
X3.23-1985 Programming Language COBOL
X3.25-1976 Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.26-1980 Hollerith Punched Card Code
X3.27-1978 Magnetic Tape Labels and File Structure
X3.28-1976 Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
X3.29-1971 Specifications for Properties of Unpunched Oiled Paper Perforator Tape
X3.30-1986 Representation for Calendar Date and Ordinal Date
X3.31-1973 Structure for the Identification of the Counties of the United States
X3.32-1973 Graphic Representation of the Control Characters of American National Standard Code for Information Interchange
X3.34-1972 Interchange Rolls of Perforated Tape
X3.37-1980 Programming Language APT
X3.38-1972 Identification of States of the United States (Including the District of Columbia)
X3.39-1986 Recorded Magnetic Tape (1600 CPI, PE)
X3.40-1983 Unrecorded Magnetic Tape (9-Track 800 CPI, NRZI; 1600 CPI, PE; and 6250 CPI, GCR)
X3.41-1974 Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange
X3.42-1975 Representation of Numeric Values in Character Strings
X3.43-1986 Representations of Local Time of Day
X3.44-1974 Determination of the Performance of Data Communication Systems
X3.45-1982 Character Set for Handprinting
X3.46-1974 Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)
X3.47-1977 Structure for the Identification of Named Populated Places and Related Entities of the States of the United States for Information Interchange
X3.48-1986 Magnetic Tape Cassettes (3.81-mm [0.150-Inch] Tape at 32 bpmm [800 bpi], PE)
X3.49-1975 Character Set for Optical Character Recognition (OCR-B)
X3.50-1986 Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets
X3.51-1986 Representations of Universal Time, Local Time Differentials, and United States Time Zone References
X3.52-1976 Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI) (General, Physical, and Magnetic Requirements)
X3.53-1976 Programming Language PL/I
X3.54-1986 Recorded Magnetic Tape (6250 CPI, Group Coded Recording)
X3.55-1982 Unrecorded Magnetic Tape Cartridge, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase encoded
X3.56-1986 Recorded Magnetic Tape Cartridge, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.57-1977 Structure for Formatting Message Headings Using the American National Standard Code for Information Interchange for Data Communication Systems Control
X3.58-1977 Unrecorded Eleven-Disk Pack (General, Physical, and Magnetic Requirements)
X3.60-1978 Programming Language Minimal BASIC
X3.61-1986 Representation of Geographic Point Locations
X3.62-1987 Paper Used in Optical Character Recognition (OCR) Systems
X3.63-1981 Unrecorded Twelve-Disk Pack (100 Megabytes) (General, Physical, and Magnetic Requirements)
X3.64-1979 Additional Controls for Use with American National Standard Code for Information Interchange
X3.66-1979 Advanced Data Communication Control Procedures (ADCCP)
X3.72-1981 Parallel Recorded Magnetic Tape Cartridge, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.73-1980 Single-Sided Unformatted Flexible Disk Cartridge (for 6631-BPR Use)
X3.74-1981 Programming Language PL/I, General-Purpose Subset
X3.76-1981 Unformatted Single-Disk Cartridge (Top Loading, 200 tpi 4400 bpi) (General, Physical, and Magnetic Requirements)
X3.77-1980 Representation of Pocket Select Characters
X3.78-1981 Representation of Vertical Carriage Positioning Characters in Information Interchange
X3.79-1981 Determination of Performance of Data Communications Systems That Use Bit-Oriented Communication Procedures
X3.80-1981 Interfaces between Flexible Disk Cartridge Drives and Their Host Controllers
X3.82-1980 One-Sided Single-Density Unformatted 5.25-Inch Flexible Disk Cartridge (for 3979-BPR Use)
X3.83-1980 ANSI Sponsorship Procedures for ISO Registration According to ISO 2375
X3.84-1981 Unformatted Twelve-Disk Pack (200 Megabytes)(General, Physical, and Magnetic Requirements
X3.85-1981 1/2-Inch Magnetic Tape Interchange Using a Self Loading Cartridge
X3.86-1980 Optical Character Recognition (OCR) Inks
X3.88-1981 Computer Program Abstracts
X3.89-1981 Unrecorded Single-Disk, Double-Density Cartridge (Front Loading, 2200 bpi, 200 tpi) (General, Physical, and Magnetic Requirements)
X3.91M-1987 Storage Module Interfaces
X3.92-1981 Data Encryption Algorithm
X3.93M-1981 OCR Character Positioning
X3.94-1985 Programming Language PANCM
X3.95-1982 Microprocessors – Hexadecimal Input/Output, Using 5-Bit and 7-Bit Teleprinters
X3.96-1983 Continuous Business Forms (Single-Part)
X3.98-1983 Text Information Interchange in Page Image Format (PIF)
X3.99-1983 Print Quality Guideline for Optical Character Recognition (OCR)
X3.100-1983 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Packet Mode Operation with Packet Switched Data Communications Network
X3.101-1984 Interfaces Between Rigid Disk Drive(s) and Host(s)
X3.102-1983 Data Communication Systems and Services – User-Oriented Performance Parameters
X3.103-1983 Unrecorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in)
X3.104-1983 Recorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in), Phase Encoded
X3.105-1983 Data Link Encryption
X3.106-1983 Modes of Operation for the Data Encryption Algorithm
X3.110-1983 Videotex/Teletext Presentation Level Protocol Syntax
X3.111-1986 Optical Character Recognition (OCR) Matrix Character Sets for OCR-M
X3.112-1984 14-in (356-mm) Diameter Low-Surface-Friction Magnetic Storage Disk
X3.113-1987 Programming Language FULL BASIC
X3.114-1984 Alphanumeric Machines; Coded Character Sets for Keyboard Arrangements in ANSI X4.23-1982 and X4.22-1983

(Continued on reverse)

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